Space Weather Technical Forecast

Issued on Tuesday, 23 July 2024 at 01:11 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1 Likely today. G2 Likely UTC day of Wednesday 24 July, Chance G3. R1 Likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity as measured at GOES16 was Moderate, with occasional M-class flares observed that peaked with an M3.9 at 22/0404UTC from AR3762 in the southeast.

There are currently up to nine regions on the solar disc, with AR3764 and AR3763 both rotating onto the eastern solar horizon in the period as AR3744 departed the west. Changes in the period were generally slower and more modest than over the past UTC weekend, with AR3761 showing slight penumbral growth in its leading group, as was the case with AR3762 to the east. AR3751 by contrast showed a fading tendency in its trailing portion, as did AR3759 to its west.

There was no evidence of new Earth-directed Coronal Mass Ejections (CMEs) seen in the period, however there was a large narrowly far-sided event from the southeastern limb that dominated coronagraph imagery during the UTC evening. This feature plays no part in the forecast.

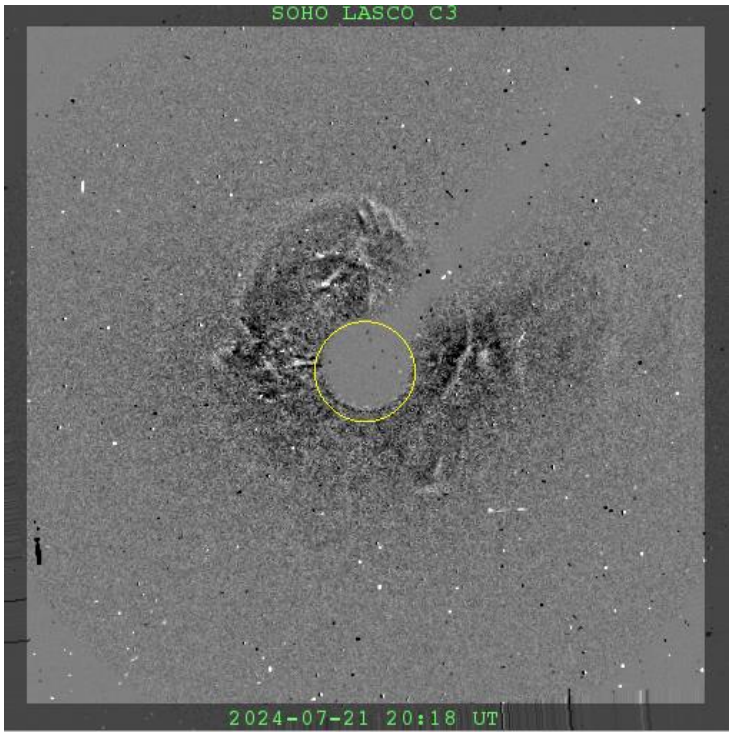

Figure 0: Lasco C3 difference imagery of the 21 July filament lift-off CME from the vicinity of AR3757, showing a north-shifted full halo. This feature is due to reach Earth during the early hours UTC of 24 July.

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Solar Wind / Geomagnetic Activity: Potentially of note, the ACE EPAM LEMS trace has been rising through the current UTC evening, which may hint at an inbound CME. The solar wind, as measured by ACE at L1, otherwise showed a continuation of a slow regime, albeit with an unusually stable and anti-aligned (with Earth's field) Bz component (between -7 and +6nT), with the IMF showing a gradual rise to become Slightly Elevated at 10nT into the UTC evening. The solar wind speed was more subdued in oscillating about 300km/s, while the solar wind density was within single figures ppcc throughout. The phi angle was away from the Sun (positive) throughout.

The net result of the above solar wind measures was for Quiet to Unsettled geomagnetic indices, with a provisional peak of Kp '3o' in the 06-09 and 09-12UTC intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 showed a slight rise in the period, beginning around 22/0600UTC. The causative mechanism is not clear - however the rise was gradual which perhaps implies a far-sided or eastern solar hemisphere source as being most likely, which might point at the trio of M-class flares from AR3762 in the southeast as being the most likely culprits. Even at peak, the flux was less than 0.5pfu, but this may may make AR3762 one to watch as it crosses the disc.

High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background. The 24-hour fluence was well below Active, with 9.57e5 integrated pfu observed at 23/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely throughout. While Ex-AR3744 has now departed the disc, its loss is in some way compensated for by the flaring into life of AR3762 in the southeastern disc.

Solar Wind /Geomagnetic Activity: No fast winds feature in the forecast period. Two CMEs are expected - the first from a filament eruption that left the Sun on 19 July which is due inside the first 24 hours - this is Likely to give G1 conditions. Secondly, a full-halo CME that left the Sun on 21 July from the immediate east of AR3757 is due in the early hours of 24 July. This is Likely to give G2 conditions, with a Chance of G3 in the UTC day of 24 July. A gradual decline to Quiet geomagnetic activity is then expected into the second half of the UTC working week, barring new CMEs.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at Background levels, but with a Slight Chance of rising above the S1/Minor Storm threshold in response to any notable flares - perhaps now increasingly likely from AR3762 in the southeast as it tracks westwards.

High energy electron flux is expected to remain at Normal Background levels initially, however confidence decreases into the second half of the UTC working week given inbound CMEs. There is perhaps an eventual Slight Chance of Active 24-hour integrated fluence.

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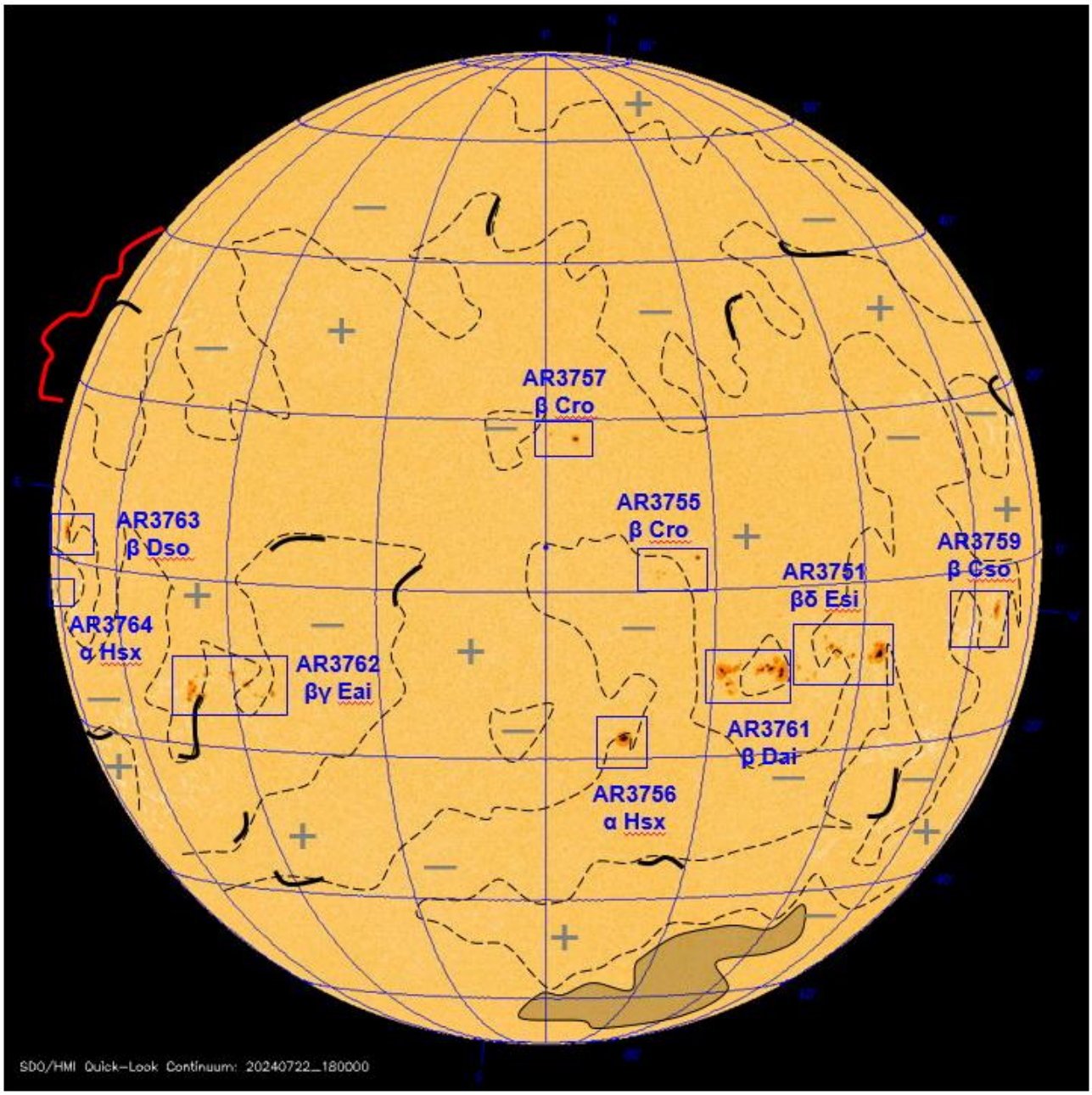
Figure 1. Solar Analysis Valid 22/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No fast winds feature in the forecast period, however there are now up to two CMEs.

The first CME - a south-central filament eruption that left the Sun on Friday 19 July - is due to arrive at Earth in the early UTC hours of Tuesday 23 July. On its own, this is expected to bring a Chance of Minor Geomagnetic Storm G1 conditions.

Secondly, a filament lift-off was observed at 21/1630 UTC. The ejecta was soon followed by a full halo CME on Lasco coronagraph imagery. An Earth-directed CME may arrive either late in the current UTC day (23 July), bolstering the G1/G2 risk and introducing a Sight Chance of G3, or more likely this CME should arrive during the early hours UTC of 24 July. This brings with it a Likely G2, and a Chance of G3 - the peak risk for the four-day period as a whole.

MOSWOC Enlil modelling currently treats the two inbound CMEs as distinct entities, however there is a small chance that the two agglomerate into one combined arrival, which would tend to favour the G3 outcome if they arrive on the earlier end of forecast expectations. The most likely case remains for separate events however, with the second almost certainly the larger of the two. Geonagnetic activity should begin to wane into day three, Thursday 25 July, with Quiet conditions likely to see out the current UTC working week, barring new emissions perhaps from AR3762 in particular given its approach to centre-disc by this time.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	70	20	1
Strong	G3	No	10	30	1	1
Severe	G4	No	1	2	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0400	Partial	Filament Eruption	S-Centre	615 km/s	23/0800 UTC +/- 9 hours	Northern portion of filament eruption, second of the two
21/1620	Full	Filament liftoff	NE quadrant	1050 km/s	24/0300 UTC +/- 9hrs	Low confidence

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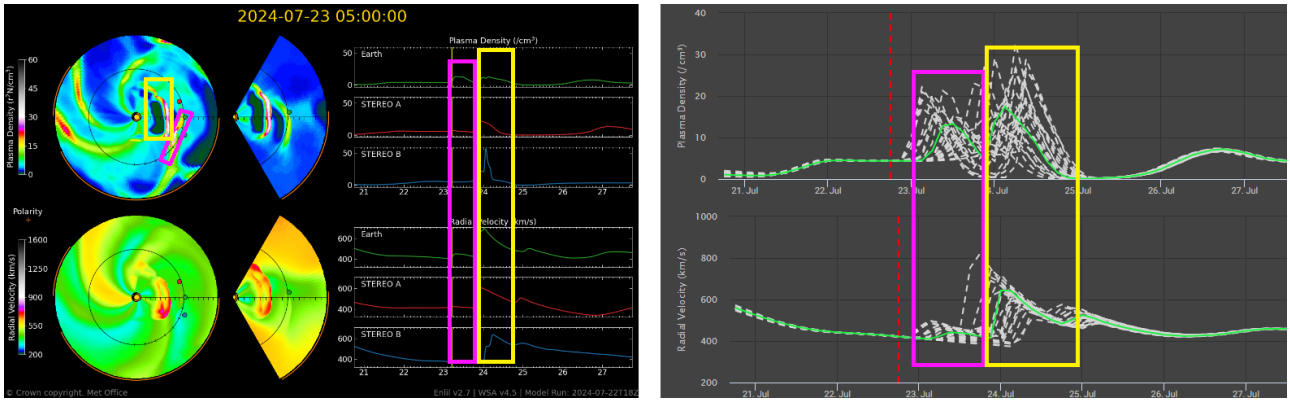
Figure 2: Latest available MOSWOC Enlil and ensemble, badge time 22/1800UTC. The simulation is paused at the 1AU arrival time of the magenta-boxed 19 July CME, with the larger 21 July CME shown boxed yellow in transit. The arrivals are separately resolved in most output and this is the expected course of events.



Radio Blackouts - X-Ray Flares:

The only sunspot region that is due to rotate off the Earth-facing disc in the period is not playing a significant role in daily flare risks. Given a probable similar lack of arriving regions, the current crop of sunspot regions are likely to largely survive the whole four-day period, and daily risks of M and X class activity are therefore held constant through the period.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	60	60	60	60
Very Active	**R3 to R5 X Class**	No	5	5	5	5

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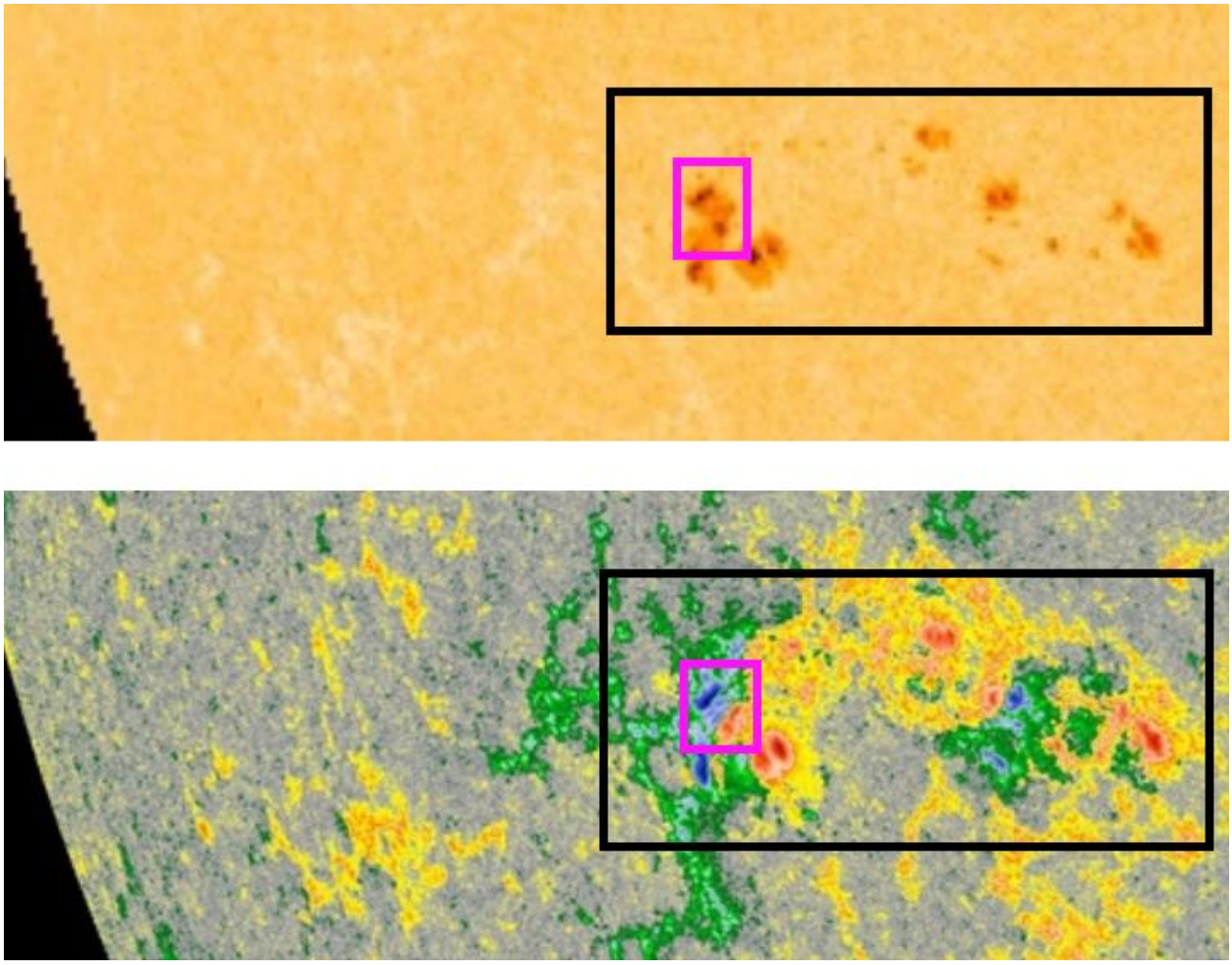
Figure 3: HMIIF and HMIBC imagery from 22/2300UTC showing AR3762 and its magenta-boxed Mt Wilson delta spot candidate.



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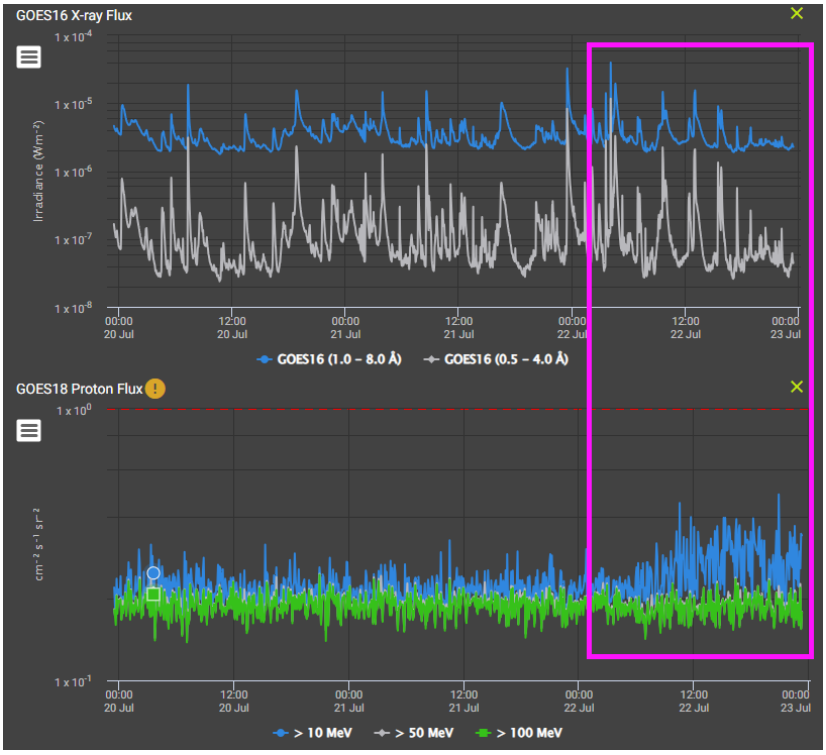
Solar Radiation Storms - (High Energy Protons):

GOES18 proton flux showed a slight rise in the period, beginning around 22/0600UTC. The causative mechanism is not clear - however the rise was gradual which perhaps implies a far-sided or eastern solar hemisphere source as being most likely, which might point at the trio of M-class flares from AR3762 in the southeast as being the most likely culprit. Even at peak, the flux was less than 0.5pfu, but this may may make AR3762 one to watch as it crosses the disc.

The probability of events breaching S1 increases very slightly over time as some of the more complex groups travel ever-westward, with some evidence of enhancement in the past 24 hours. If AR3762 is indeed the cause of this, then the probabilities can be expected to increase, more than compensating for Ex-AR3744's declining contribution on the far side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Past 72 hours of GOES16 X-ray flux and resulting GOES18 proton flux. The most probable culprits for the slight 10MeV response are the triplet of eastern solar hemisphere M-class flares from AR3762



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High Energy Electrons Event (≥ 2MeV):

The high energy electron flux as observed by GOES16 is currently at Normal Background and is expected to persist at this level initially. Persistence methods and MOSWOC REFM are not expected to offer a useful steer to eventual fluence levels in the period, owing to the dominance of CMEs in the forecast. On balance, confidence decreases sharply through midweek in current Background levels being maintained, with an eventual rising Slight Chance of Active later in the UTC week once geomagnetic activity wanes.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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